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JUL 25 1997

CALFED Bay-Delta Program Office
1416 Ninth Street, Suite 1155
Sacramento CA 95814

Research Proposal Entitled
"Models Integration, Ecosystem Sensitivities, Monitoring Regimes Project"
RFP: 1997 Category III Ecosystem Restoration Projects and Programs
Principal Investigator - Wesley W. Wallender

Dear Colleague:

It is our pleasure to present for your consideration the referenced proposal in response to **the CALFED Bay-Delta Program RFP.**

Please call on the principal investigator for scientific information. Administrative questions may be directed to me or my assistant, René Domino, at the above address and phone number. We request that correspondence pertaining to this proposal and a subsequent award be sent to the Office of Research and to the principal investigator.

Sincerely,

Sandra M Dowdy JUL 25 1997
Sandra M. Dowdy
Contracts and Grants Analyst

Enclosure

cc: W. W. Wallender

I. EXECUTIVE SUMMARY

Title: Models Integration, Ecosystem Sensitivities and Monitoring Regimes Project

Applicant Name: University of California at Davis; Department of Land, Air and Water Resources

Project Description: This project will simulate and model the hydrologic processes of a variety of watersheds within the Cosumnes River Basin, and then merge this model with alternative land management and atmospheric and natural ecosystem scenarios in order to measure the sediment pick-up and deposition, water flow, water clarity, and temperature impacts over time. The output of these simulations will be used to characterize the sensitivity and inter-relationships of the relevant ecosystem processes, habitats, species and stressors. The end product will be a monitoring regime to measure sedimentation, water flow, water clarity, and temperature at critical points in individual watersheds. These streambed measurements will then be aggregated and interpreted to define cumulative effects, which in conjunction with satellite imagery or aerial photographs will indicate the relative health and any significant changes in both the aquatic and terrestrial resources.

The comprehensive sensitivity analysis of ecosystem elements and the monitoring regime that will be developed will be suitable for adaptation to other study areas. An on-line interactive watershed demonstration will serve as a teaching tool for landowners, land planners, environmentalists, students and the general public.

Primary Biological/Ecological Objectives: These primary objectives are to perform ecosystem modeling and monitoring on critical watersheds in the Cosumnes River Basin to enhance specific habitats - seasonal wetland and aquatic, instream aquatic, and shaded riverine aquatic - through policy and programmatic action development, which will in turn result in the amelioration of a host of stressors currently acting on the fall run chinook salmon and Sacramento splittail.

Approach/Tasks/Schedule: This will be a three phase, three year project. The approach will involve modeling an upper forested watershed and integrating the models in phase I, modeling a lower watershed with primary emphasis on grazing and agriculture in Phase II, and modeling a selection of three diverse watersheds in Phase III. Upon completion, a Monitoring Plan, Sensitivity Report, and on-line Demonstration program will be delivered. Each phase will be one year in duration.

Justification for Project and Funding by CALFED: By reducing scientific uncertainties, the monitoring regime will strengthen watershed management planning and decision-making - thus benefiting both species of concern and the ecological functions associated with their habitats. An effective landscape level monitoring and assessment system will inevitably lead to improved water quality and other associated properties, both within the tributary watersheds and in the Bay and Delta.

Budget Costs and Third Party Impacts: Total budget costs are $1,114,863 over three years. Year 1 costs are $395,705, year 2 $355,653 and year 3 363,505. There are no anticipated negative third party impacts.

Applicant Qualifications: Wesley Wallender, Professor of Hydrology and Geographic Information Systems (GIS), has developed a hydrologic model suitable for integrated watershed modeling and measurement at a regional scale which will be used to measure sedimentation, water flow, and water quality effects associated with alternative stressors. Susan Ustin, Associate Professor of Resource Science and chair of the Center for Spatial Technologies, is a principal investigator of several NASA sensor programs for earth observation, including EOS. VESTRA Resources Inc., a GIS firm with wide-ranging capabilities in applications design, impact assessments, hardware and software configuration, and strategic planning, has developed the Ep(x) model for the purpose of sustained yield planning and ecosystem management. Peter Moyle, Professor of Wildlife and Fisheries Biology, will conduct and evaluation of suitable habitat for fall run salmon. Scott Holmen, senior software developer, and L. Russell Fletcher, senior operations research analyst, will have the lead for VESTRA in merging Ep(x) and a stochastic fire disturbance model - developed by Dr. Fletcher at the University of California at Berkeley - with the hydrology model.

Monitoring and Data Evaluation: Data will be ground-truthed and validated by remote sensing and expert perusal where feasible and economical. Existing data sources for the study area include the U.S.F.S., U.S.G.S, Sierra Pacific Industries, and mush data exist from prior SNEP case studies (SNEP, vol. II & III).

Local Support/Coordination with Other Programs/Compatibility with CALFED objectives: An oversight panel has been established to ensure effective interaction and coordination with complementary activities such as the Cosumnes Partnership and the Cosumnes River Project, and to make certain that the results of this work are compatible with the land management practices of local parties with responsibilities and interests in the watershed. The objective of the panel is to foster synergy among research programs, rather than redundancies, and to ensure that the final product is judged as both useful and scientifically credible.

Participants on the panel include representatives of the Eldorado National Forest, the Bureau of Land Management's Folsom Resource Area Office, the California Department of Forestry and Fire Protection, the USFS Pacific Southwest Experiment Station, the El Dorado County Board of Supervisors, the Nature Conservancy, the El Dorado Resource Conservation District, the Amador County Resource Conservation District, Sierra Pacific Industries, the Universities of California at Davis and Berkeley, the Forest Landowners of California, and the National Watershed Management Council.

This project is directed toward removing areas of scientific uncertainty related to defining priorities for restoration of ecosystem processes and aquatic and terrestrial habitats, and reducing stressors related to specific priority habitats and species. .

II. TITLE PAGE

Title: Models Integration, Ecosystem Sensitivities and Monitoring Regimes Project

Name of Applicant/Principal Investigators:

Submitted by: The Regents of the University of California, Davis Campus
Office of the Vice Chancellor for Research
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Principle Investigators:

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Type of Organization: The University of California at Davis is a Land-Grant University, and is tax exempt.

Tax Identification Number: 94-6036494-W

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Project Group Type: Other Services

III. PROJECT DESCRIPTION

a. Project Description and Approach

Our proposal will focus on the simulation and modeling of the hydrologic process on a variety of watersheds within the Cosumnes River Basin, and will merge land management scenarios with atmospheric and natural ecosystem processes over time, to measure the sediment pick-up and deposition, sediment loading, and water clarity and temperature resulting from these interactions. The results of these simulations will be used to characterize the sensitivity of the relevant ecosystem processes, habitats, species and stressors within that watershed. The final products will include a monitoring plan that will measure sedimentation, water flow, water clarity and temperature at critical areas in and along the river as identified by the modeling process. A detailed sensitivity analysis report covering the ecosystem elements addressed in the project will also be assembled. In addition, the entire simulation process will be adapted for on-line use as an interactive, adaptive management, watershed demonstration program for general public use.

The component parts and linkages of the overall model structure are depicted in Figure 1. The first component is the Ecosystem Planning Express, or Ep(x), model developed by VESTRA Resources, and currently used to develop long-term forest ecosystem plans for several major forest and range landholders in California. A detailed operational structure of Ep(x) is shown in Figure 2. The Ep(x) model will be used to develop sets of land use scenarios, and will pass the relevant outputs of those scenario solutions as inputs to the hydrologic model. The hydrologic model is shown in detail in Figure 3, and was developed at the University of California, Davis, by principal investigators Drs. Wesley W. Wallender and Susan L. Ustin, to measure the hydrologic process with respect to sedimentation, water flow and water quality as a function of atmospheric, geologic, vegetative and land use inputs. The fire simulation model as shown in Figure 4 was developed at the University of California, Berkeley, by Dr. L. Russell Fletcher, and was used successfully as part of a funded stochastic ecosystem study in the Tahoe National Forest. As shown in Figure 1, the fire simulator can be included or excluded from the model depending on the requirements of the scenario being modeled. Both the fire simulation and hydrologic models are written in the "C" programming language, and both take a GIS grid-based, raster input format. The output of the Ep(x) model is polygon-based and can easily be converted to grid-base.

<u>**Approach**</u>

Our initial approach will be to model the Clear Creek (20,821 acre) and Camp Creek (7580 acre) watersheds in the eastern and upper regions of the Cosumnes River Basin (see Figure 5). These watersheds were modeled extensively as case studies for the Sierra Nevada Ecosystem Project (SNEP, vol. II), and much data on them exists which can be utilized directly in our models. In addition, several of our team members were directly involved in the SNEP effort and are intimately familiar with the study area. For these watersheds, data will be collected and compiled, and input to the model structure in the applicable sequence(s) as shown in Figures 1-4. All elements of the model will then be fully stressed, with both the model and data sets undergoing rigorous validation.

While our model could be classified as a low-certainty model, one of its advantages is that it offers the opportunity to investigate wide ranges of input scenarios to the watersheds, and provides a comprehensive sensitivity analysis on each of the ecosystem elements, namely the ecological processes, habitats, species and stressors. As part of the scenario development process, ranges of policies and programmatic actions will be defined, run through the modeling process, and the sensitivity of each of the ecosystem elements to those policies and actions will be recorded. We will also obtain current watershed management plans for all areas being modeled, and input these into our model using the results as a control for our scenario development runs.

While the effects of any scenario on these upper reaches of the basin will have effects on downstream watersheds, the particular priority species which we will be addressing - the fall run chinook salmon (*Oncorhynchus tshawytscha*) and the Sacramento splittail (*Pogonicluthys macrolepidotus*) - reside in the lower and western watersheds of the basin down to and into the Delta. For this reason, and having refined and validated the model on the upper reaches, we will then collect data and conduct similar scenario management simulations on three or four lower watersheds located directly within the habitat ranges (or historical ranges) of these species. All scenario results will be compared and contrasted to those from existing watershed management plans.

Based on the results of our simulations, one of the final deliverables will be a proposed monitoring plan for the length of the Cosumnes River Basin which will designate temporal site-specific locations in the watershed which would be appropriate for installation of measuring equipment to monitor sedimentation pick-up and deposition, water flow, water clarity, and water temperature. This will be delivered as a GIS coverage. We will also provide complete sets of sensitivity analyses on each of the applicable ecosystem elements for each scenario within the watersheds modeled. These modeling efforts and results should be invaluable to other researchers, analysts and managers conducting similar studies and restoration projects within the Delta or in the upper watersheds. The model structure and operation would be readily adaptable to any scale and watershed location.

The Ep(x) model

The Ep(x) model begins with the collection of the relevant input data sets as shown in Figure 2. A planning horizon is selected, and time increments within that horizon are defined. Strata types on the landscape are then delineated based on the homogeneity of vegetation and site class, and these are processed through a growth and yield simulator which outputs the size and density class structure, and growth and harvest volumes, over time as a function of the allowable silvicultural prescriptions applied to that strata type. This growth and yield simulator currently models only tree species, but will be adapted for grazing and agriculture simulations as well. The output of this simulator is called the Resource Capability Model (RCM), and assumes a database structure, with individual tables defining the specific attributes (growth, harvest, habitat ...) for each time period on a per acre basis for each of the strata/silviculture prescription combinations. In simpler terms, it defines the potential productivity of the ecological system over time from a biological perspective regardless of the political, legal or policy level constraints that are sure to be imposed in a later stage of the planning process.

Concurrent with the above processing, various attributes such as ownership, special concern areas, allowable logging methods, and watershed boundaries are overlaid to further delineate the strata types into homogeneous landtypes based on those political and spatial attributes. Thus our landscape analysis unit has decreased in size and increased in overall numbers. This landtype unit, coupled with the allowable silvicultural, grazing or agricultural regimes, then becomes the decision variable for subsequent processing through the linear programming (LP) module. The Policy (scenario) Alternative Model (PAM) is also constructed, and it is within this module that various policy constraints and programmatic actions will be defined over and/or for each or any of the ecological processes, habitats, species and stressors. The RCM and PAM are then joined via a custom software product, and are reconstructed in the format required for LP processing. The LP model then outputs the optimal assignment of individual landtypes to specific allowable silvicultural, grazing or agricultural regimes based on the objective function and constraint sets specified in the PAM as filtered through the RCM. Various properties and effects of these landscape assignments are subsequently calculated or determined, and are used in the sensitivity analysis or are input into the next phase of the modeling process. As an example, and referring to Figures 1-3, from the landtype assignments from the Ep(x) model, leaf area index and surface roughness properties are subsequently calculated based on such factors as the effect on the landscape of the particular silvicultural prescription selected (i.e., clear cut vs. selection) and logging method used. Soil properties may also have been changed if fire regimes had been modeled in the scenario. These outputs are then used as inputs to the hydrologic model.

For purposes of this project we have selected a ten year planning horizon, and will be performing growth and yield simulations at one year increments. Scenario sensitivity analyses for each of the ecological processes, habitats, species and stressors will be developed and presented in a time-line format. While policy and constraint set formulations are more readily understandable, the concept of the objective function within this particular project requires further explication. Defining the objective function, and whether it is to be maximized or minimized, is a requirement of the LP process. Within this project, classical objective functions such as maximizing profit or harvest may not be as relevant as objective functions such as minimizing overall or segmental sedimentation, minimizing variations from stated desired levels of sedimentation, or minimizing loss of riparian habitat. Both extremes will be modeled so that we can establish the complete effect and range of various policies and programmatic actions on each of the ecological processes, habitats, species and stressors under consideration.

The hydrologic model

The atmospheric, hydrological and aquatic biological inputs to this model are shown in detail in Figure 3. Leaf area index, surface roughness and soil properties are input from the Ep(x) model as described based on the particular scenario development. Other input parameters are gathered from atmospheric models or existing weather or biologic data sources. Water enters the system as rain, and, depending on these input parameters, flows from the forest canopy and/or landscape surface through the various soil horizons and directly or indirectly into the stream channel. The water exiting the system and the processes involved are shown as outputs.

The output of the model is currently surface and ground water flow, velocity over time and space. Subsequent phases will include developing facilities for measuring sediment pick-up and deposition, sediment load in the overland flow, amount of sediment in the water flow itself, water clarity and water temperature. These predictions can subsequently be used to predict stream movement and geometries.

The fire model

Wildfire is one of the primary stressor groups that we propose to address. It can be at the same time both detrimental to one set of ecosystem elements and restorative to an adjacent set. It is one of the most politically sensitive of stressors, and is frequently addressed by inaction as a result of that property. We are all aware of disastrous fires resulting from presuppression and suppression policies. We will be incorporating fire policy and restoration actions related to fire management, or lack of management, into our scenarios.

The fire generator works as shown in Figure 1 and Figure 4, and can be turned on or off depending on the scenario. It can also be operated in either manual or automatic mode. Manual mode involves selecting the fire start location (coordinate), fire size and fire arrival time, as well as direction of fire spread and intensity. The automatic mode generates multiple fires according to the fire size distribution, arrival rate distribution, probability of ignition as a function of landscape characteristics, and spread and intensity for the specific landscape area being modeled. Figure 4 depicts the automatic mode of operation.

As part of the fire scenario regimes, we will be looking at both fire policy(s) as well as specific programmatic actions applied to the landscape. Examples of fire policy might include allowing all naturally occurring fires to burn, or suppressing all such natural fires. Other policy regimes may allow fires to be suppressed if they threaten riparian vegetation. Examples of programmatic actions may include fuels management and removal, planting native vegetation after fire events, or possibly locating fire fighting personnel at strategic locations during high danger rating fire periods.

b. Location and/or Geographic Boundaries of the Project

The Cosumnes River Basin is located in El Dorado County and encompasses approximately 600,000 acres, as shown in Figure 5. The eastern and upper portion of the basin is primarily within the Eldorado National Forest, whereas the western and lower portions are primarily oak woodlands and small agricultural communities. The Clear Creek and Camp Creek watersheds are located in the uppermost eastern region of the basin and encompass 7,580 and 20,821 acres respectively. Additional watersheds to be modeled, as discussed in the previous section, will be located south of Michigan Bar since that is probably the easternmost range of the fall run chinook. Splittail are located at the mouth of the Delta where the Cosumnes converges with the Mokelumne River. There are no dams in this drainage.

c. Expected Benefits

The primary species of concern are the fall run chinook and splittail. Because of falls located at the Latrobe Highway Bridge and at the Highway 49 crossing, it is unlikely that any of the fall runs ever ran past these obstacles. It is unlikely that any fall runs have occurred in recent years (SNEP, Vol. III). Juvenile salmon move out of the Sacramento River into the mouth of the Cosumnes and Mokelumne Rivers in spring but do not venture farther upstream in the Cosumnes. Splittail move into this Delta region in March and April and require the shallow water habitat found there. Secondary species of concern, migratory bird species, will be addressed as a group in terms of their habitats, stressors and programmatic actions.

The priority habitats we will be modeling are (1) seasonal wetland and aquatic, (2) instream aquatic, and (3) shaded riverine aquatic. Seasonal wetland habitats within the Cosumnes basin present great potential for the development of programmatic actions for our modeling because of the diverse agricultural interests present on the western and lower portion of the basin. This habitat is critical to the success of chinook rearing and splittail spawning, and provides critical forage for migratory birds. Instream aquatic habitats provide the primary means of sediment transport and will be closely monitored and stressed within our modeling process, both in terms of points of sediment entry into the stream and subsequent effects on habitats and species downstream. The area in shaded riverine habitat has diminished greatly, and has not been restored either naturally or with direct human intervention to any significant extent. We will be addressing both types of restorative methods in our modeling.

The primary stressor groups we will be addressing that have significant effects on the priority species and habitats selected for modeling are land use and wildfire. Conditions caused by these stressors and substressors, however will often contribute to other stressor categories. For instance, sedimentation caused by a particular grazing land use policy may result in channel form changes or alterations of stream flow as well. We will model land use and wildfire policy, and create specific management scenarios addressing these stressors, and will track the effects of these policies on our priority species and habitats, as well as their cumulative effect on the watershed including other stressor groups, and secondary habitats and species.

Within the land use group, we will specifically be addressing grazing, forestry practices and agricultural regimes and the associated substressor groups. Grazing substressors include bank erosion due to overgrazing, lowering of the water table, damage to riparian habitat and decreases in water quality. In our management scenarios that address grazing, we will include both policy level issues such as allowable levels of grazing, along with implementing specific programmatic actions associated with restoring habitat previously decimated. These might include actions such as restoration of riparian habitat and fencing.

Substressors within the forest practices group are numerous. These include inappropriate or harmful silvicultural regimes and logging methods, improper or no planning for wildlife habitat, over-harvesting, inappropriate species harvest mixes, conversion of forest lands to grazing or agricultural use, and harvesting of steep slopes to mention a few. Each of these stressors will be modeled at various levels, and their contribution to our monitoring parameters recorded. In addition, mitigating and restorative programmatic actions for each of these stressors will be identified and modeled within a particular management scenario. Agriculture stressors to be included in the model include conversion of flood plains to agriculture use, conversion of forest and grazing lands to agriculture use, contamination of the land and water, and improper agricultural practices that result in erosion or in the degradation of soil properties. Programmatic actions include examination of ranges of agricultural regimes, reductions in use of pesticides, and irrigation level constraints. We will also investigate agricultural regimes and crops that will benefit migratory bird populations at critical times of the year.

Wildfire stressors include losses to riparian and adjacent wildlife habitats, changes in soil properties that contribute to increased surface runoff and sedimentation, and wildfires which result from improper or no fuels management plans. Programmatic actions will include implementing fuels management plans and other presuppression policies, and generating computer fire regimes to better quantify the sensitivity of the project area and other Delta watersheds to the fire phenomenon.

The expected benefits of this project are manyfold, and extend well outside the range of the Cosumnes River Basin. Upon completion of the project, we will have developed a monitoring plan that could be implemented both within the project area and in other watersheds as well. We will also have developed a comprehensive sensitivity analysis on each of the ecosystem elements addressed in the project, and this methodology could be used to model other ecosystem elements in other study areas. The on-line interactive watershed demonstration will be put on the CALFED website, and will allow users to manipulate the same ecosystem elements addressed in our project. They will be able to manipulate land management policies, both "good" and "bad", and implement programmatic actions while viewing the results of their actions on the screen. If successful, this type of demonstration could be implemented in many other diverse watersheds.

d. Background and Biological/Technical Justification

The need for and timing of this project is important because of the lack of fall run chinook within their historic range within the last several years. It may be possible to reverse this trend before the existing system becomes immobilized. The first step is modeling and characterization of the ecological processes within the current system so that we can use that knowledge to develop sets of restorative actions and policies necessary to reverse some of the previously failed policies. Previous approaches in the Clear Creek and Camp Creek watersheds have included, in the SNEP case study (SNEP, vol. II), looking at the hydrologic effects of past land use policies over the last 50 years. A second SNEP study (SNEP, vol. III), on which Drs. Wallender and Ustin participated, resulted in the development of the hydrologic model used in this project. Our proposed project will build on the SNEP models and will utilize many of the same data sets.

e. Proposed Scope of Work

There are three major phases of the project. In phase I we will link and develop the three major models using data from the Clear Creek or Camp Creek forested watersheds. Data is currently available for these areas. This phase will last approximately one year. In phase II, and having developed our models into a single model structure, we will then select a lower watershed within the range of our selected species. These watersheds are primarily oak foothills with a variety of grazing and agricultural activities occurring on the landscape. These particular activity types will be fully developed within the models, and upon completion, we will have successfully modeled and defined the sensitivity of our ecosystem with respect to forest, grazing and agricultural stressors. At the end of each phase we will also deliver draft monitoring plans, ecosystem element sensitivity analyses as well as internet demonstrations for each of the watersheds being modeled. In phase III, we will build the final three watershed models at locations to be determined, and will develop and deliver the final proposed monitoring plan, sensitivity analyses final report and on-line interactive demonstration on the CALFED website. Technical progress reports will be issued after our biannual oversite meetings and will also be available on-line. Quarterly financial and programmatic reports will be submitted as per Attachment D of this RPF. A more detailed breakdown of subtasks is shown in Section IV(b).

f. Monitoring and Data Evaluation

Many of the initial data sets for the proposed modeling effort were collected and validated in the SNEP models (SNEP, vols. II & III). In addition, for the proposed additional watershed studies, the U.S. Forest Service has relevant data sets for watersheds within the Eldorado National Forest. Data on other watersheds on the western and lower portions of the Cosumnes River Basin will be collected from U.S.G.S., remote sensing and other available sources. Both participants in this proposal have both the equipment resources and expertise in data collection and validation. In addition, ground-truthing and peer review of data sets will be conducted as is feasible and economical. We will also use remote sensing to validate data sets and also to look at the cumulative effects on the ecosystem elements.

g. Implementability

Since we will not be physically altering nor imposing our programmatic actions directly on the landscape, there should be no major political or environmental obstacles to the implementation of our modeling process. The work will be overseen by a panel of experts, who will meet semi-annually to critique the work of the project team. Dr. Larry Davis, professor emeritus in the Forestry Department at U.C. Berkeley, will facilitate the panel. This panel will include persons from the Cosumnes watershed area(s) as well as others with particular watershed management expertise to ensure that the project team takes into account any ongoing activities which could strengthen or complement this work. Meetings of the expert panel and the project team will be open to observers, and summaries will be posted on the CALFED website and mailed to interested persons. See section V for other collaborating participants.

h. Literature cited

Sierra Nevada Ecosystem Project, Final Report to Congress, vol. I-III, Assessments, Commissioned Reports, and Background Information (Davis: University of California, Centers for Water and Wildland Resources, 1996).

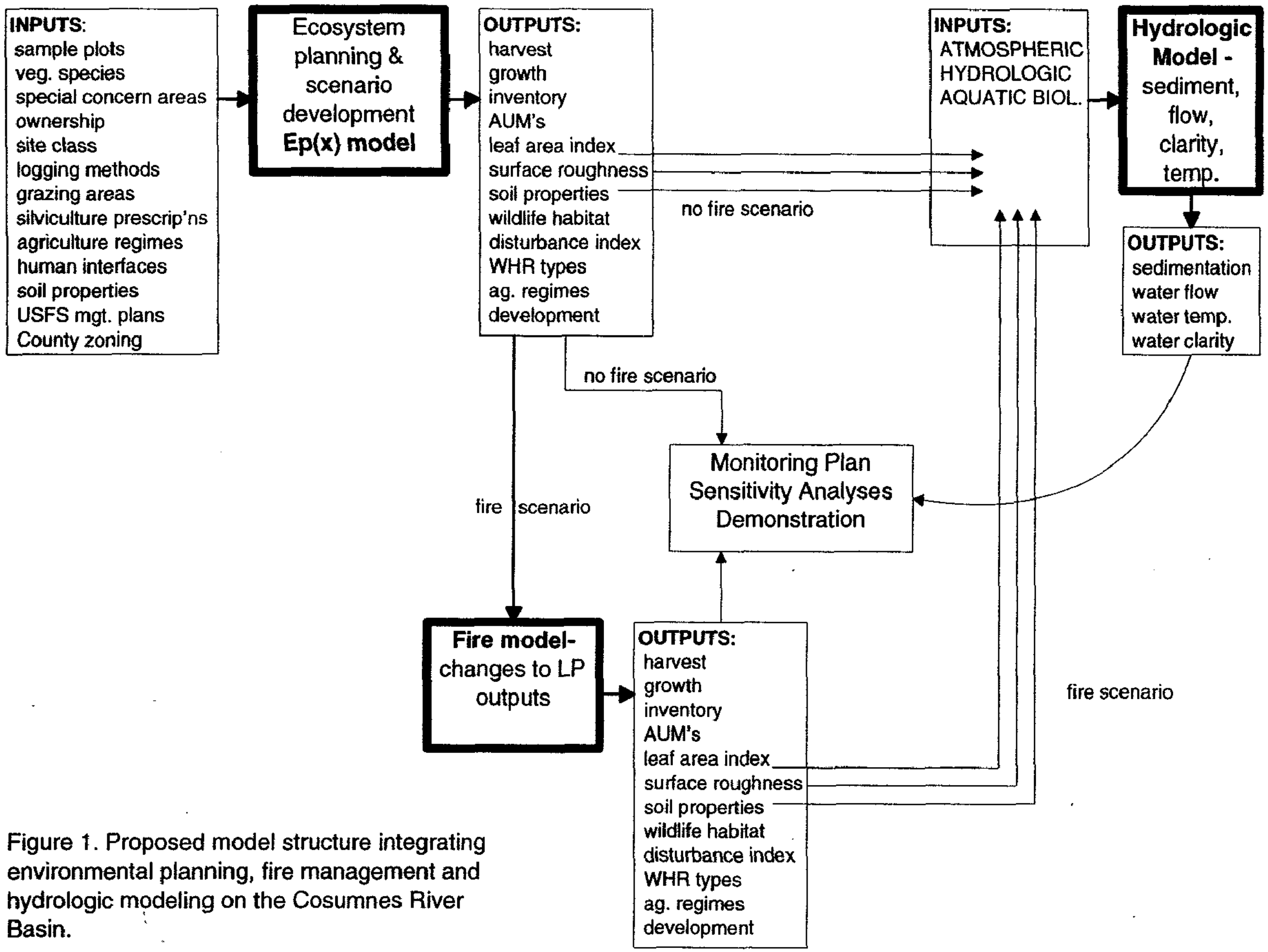

Figure 1. Proposed model structure integrating environmental planning, fire management and hydrologic modeling on the Cosumnes River Basin.

I-000716

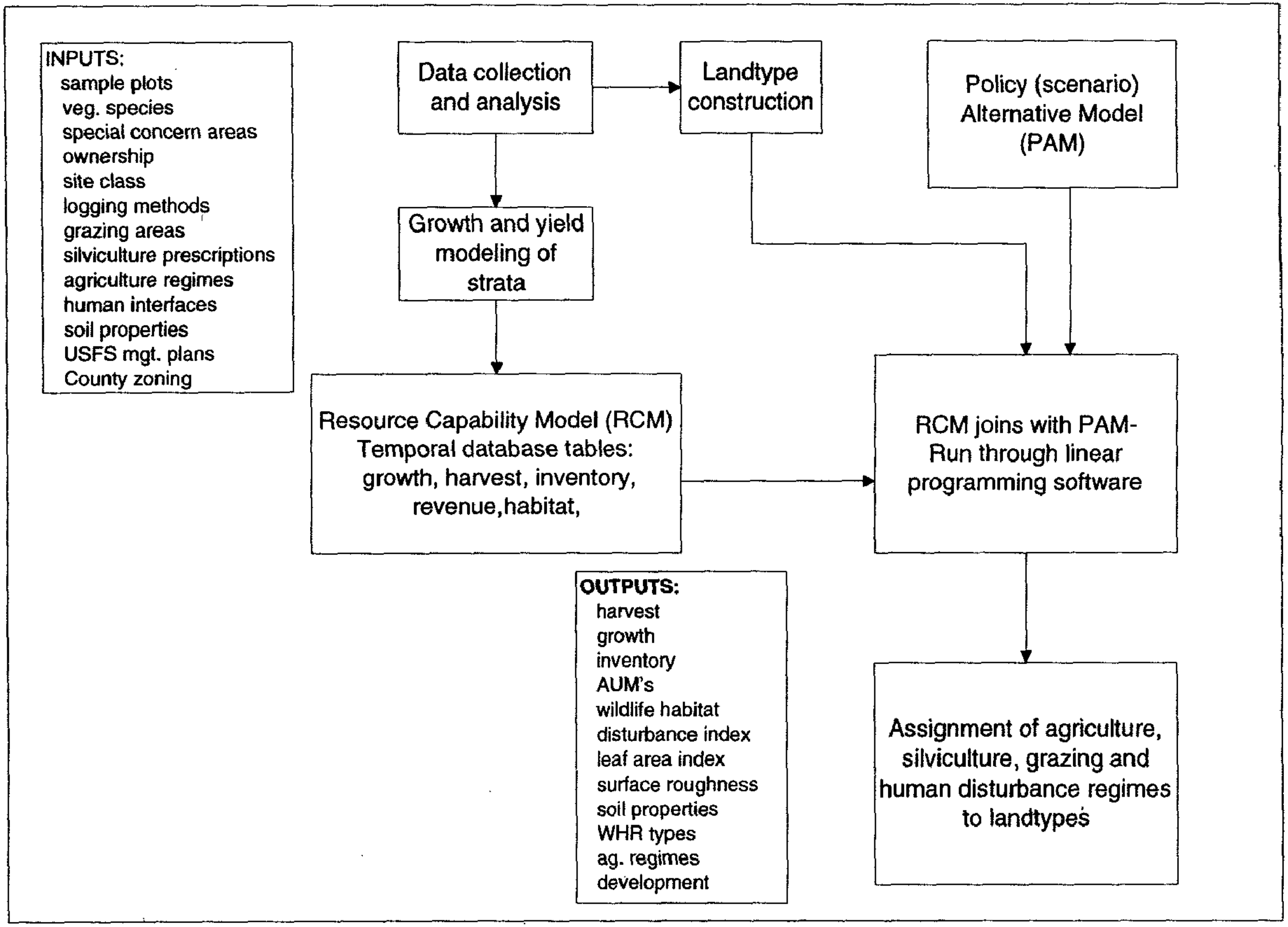

Figure 2. Ecosystem Planning Express, Ep(x), model inputs and outputs

I-000717

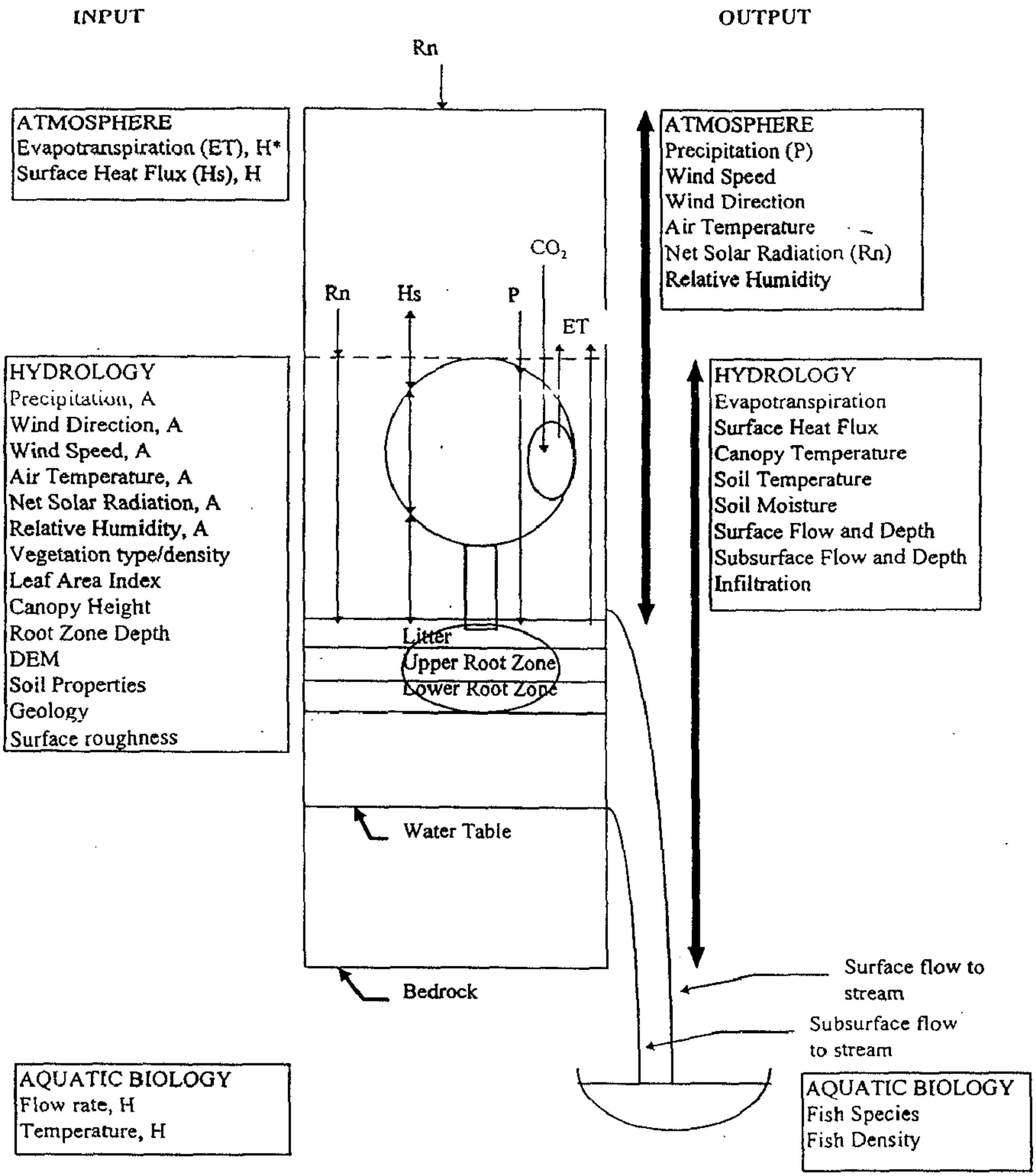

Figure 3. Hydrologic model inputs and outputs.

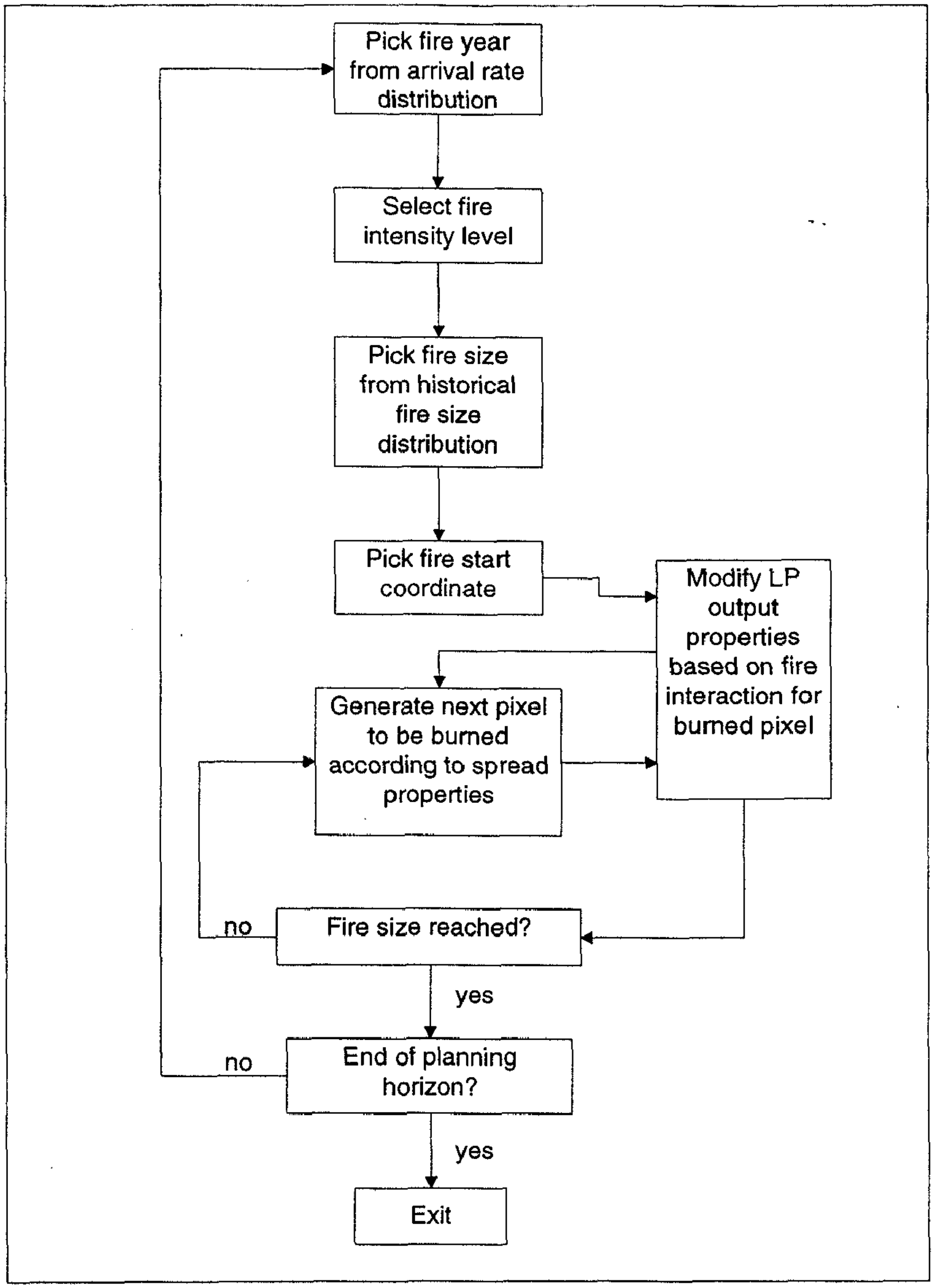

Figure 4. Fire model - automatic fire generation and processing.

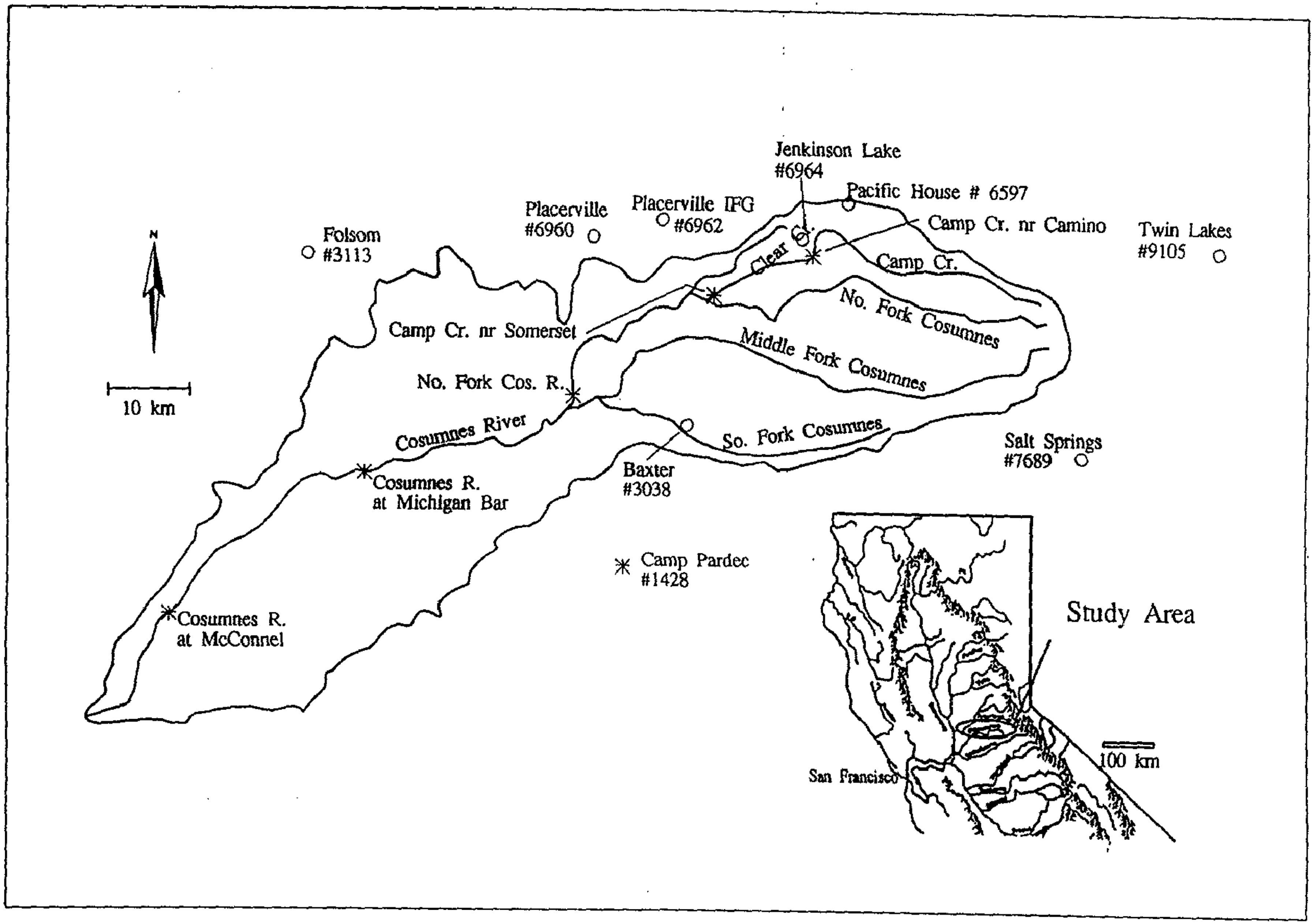

Figure 5 . Location of study area and climate (O) and discharge stations (*) in the Cosumnes River basin, California

I-000720

IV. COSTS AND SCHEDULE

a. Budget Costs

The budget costs in the categories specified in the RFP for the prime contractor are shown in Table 2. The three budget year breakdowns correspond to the three primary tasks as outlined in Table 1. In Table 2, the **Service Contracts** line item is lumped for VESTRA Resources Inc., the subcontractor. Their specific cost breakdowns are itemized in Table 3. All direct funding is requested from CALFED, and there are no O & M costs requested. While no direct funds have been solicited from other entities, we will rely on, and the budget figures indirectly reflect, data sets and assistance from U.S.F.S., U.S.G.S. and Sierra Pacific Industries personnel. In addition, U.C. Davis and VESTRA Resources have incurred considerable expense in constructing the models to be implemented in this project. In future project years we will aggressively continue to seek additional sources of funding and cost sharing in order to minimize the burden on CALFED.

The applicant is seeking sole source approval for the subcontractor, VESTRA Resources, Inc. The dominant goals set forth in this proposal require the integration of three models developed individually by both participants. The hydrology model (SPLASH) was developed by researchers at U.C. Davis, and both the fire model (FIREGEN) and the resource planning model (Ep(x)) were developed by VESTRA Resources, Inc. This proposal effort would not be possible without this union of both parties. A letter requesting sole sourcing is attached.

b. Scheduled Milestones

Primary and subtasks are outlined in Table 1. The primary tasks are each approximately one year in duration, and specific subtasks will be started and completed in the specific quarters (Q) shown. Key milestones and their anticipated achievement dates are:

Phase I

1. Initial linking and operation of the three models - Dec., 1997.
2. Develop fire and Ep(x) models fully for study area - March, 1998.
3. Perform scenario run sets and evaluate sensitivities of ecosystem elements - June, 1998.
4. Develop first draft and working model of internet application - June, 1998.
5. Develop first draft of Monitoring Plan for initial watershed - Sept., 1998.

Phase II

1. Develop agriculture and range ecosystem relationships - Sept., 1998.
2. Review and refine ecosystem relationships with stakeholders - Oct., 1998
3. Run scenarios on lower watershed - March, 1999.
4. Review and refine ecosystem relationships for upper and lower watersheds - June, 1999.
5. Update internet application for foothills watershed - Sept., 1999.
6. Develop draft Monitoring Plan for foothills watershed - Sept., 1999.

Phase III

1. Review and refine ecosystem relationships with stakeholders for forested and foothill watersheds - Nov., 1999.
2. Run scenarios on 3 additional watersheds - March, 2000.
3. Final interactive demonstration installed - Sept., 2000.
4. Final ecosystem element sensitivity analysis report - Sept., 2000.
5. Final Monitoring Plan - Sept., 2000.

c. Third Party Impacts

It is not anticipated that there will be any adverse third party impacts. We have gone to great lengths to include inputs from academia, public agencies, private landowners and industry representatives. Results from this project will have broad applications over a wide variety of watershed types, and the technologies and methodologies developed during the project will be made available to all interested parties.

Primary Task/Phase I, October, 1997 - October, 1998:
Build single forest watershed demo. Research/build relationships for Ep(x), hydrologic and fire models on forested landscape.

Subtasks:

1. Acquire/build GIS - QIV
2. Preliminary tree growth and yield modeling- QIV
3. Preliminary fire modeling - QI
4. Scenario development and alternative runs (3-5 ea.) - QI
5. Explore relationships of forestry activities and hydrologic outputs to ecosystem elements - QII
6. Develop internet application/demonstration - QII
7. Draft monitoring plan and sensitivity analyses on ecosystem elements - QIII
8. Get stakeholder reactions - QIII

Primary Task/Phase II October, 1998 - October, 1999:
Build single foothill watershed demo. Research/build relationships for Ep(x), hydrologic and fire models - include agriculture and range management elements

Subtasks:

1. Review relationships with stakeholders from forested runs. Research/build relationship structure in foothill watershed including range and agriculture - QIV
2. Acquire/build GIS - QIV
3. Preliminary modeling activities and yields - QI
4. Model scenarios - QI
5. Explore relationships - forestry, fire, agriculture, range and development with respect to the ecosystem elements - QII
6. Internet demo - solicit comments from on-line - QIII
7. Draft monitoring plan and sensitivity analyses - QIII

Primary Task/Phase III-October, 1999 - October, 2000:
Build final 3 watershed models based on adaptive management

Subtasks:

1. Review relationships with stakeholders, research/build relationships - Ag., range, forested, development - QIV
2. Acquire/build GIS - QIV
3. Preliminary modeling activities and yields - QI
4. Model scenarios - QI
5. Explore relationships - forestry, fire, agriculture, range and development with respect to the ecosystem elements - QII
6. Final interactive demonstration installed - QIII
7. Final ecosystem element sensitivity analysis report - QIII
8. Final monitoring plan - QIII

Table 1. Project tasks and phases.

BUDGET-UNIVERSITY OF CALIFORNIA DAVIS

COST CATEGORY	1997-98 BUDGET RATE	1997-98 BUDGET AMOUNT	1998-99 BUDGET RATE	1998-99 BUDGET AMOUNT	1999-2000 BUDGET RATE	1999-2000 BUDGET AMOUNT	TOTAL BUDGET
Direct Salaries and Benefits							
2 Postgraduate Researcher VI (100%)	35,557	71,114	37,335	74,670	39,202	78,404	224,188
Direct Labor Hours	2,080	4160	2,080	4160	2,080	4160	
Benefits	0.19	13,512	0.19	14,187	0.19	14,897	42,596
Total Direct Salaries and Benefits		84,626		88,857		93,301	266,784
Overhead Labor	0.445	37,659	0.445	39,541	0.46	42,918	120,118
Service Contracts							
Vestra		222,120		222,120		222,120	666,360
Overhead Service Contracts (first $25,000)	0.445	11,125		0		0	11,125
Total Service Contracts		233,245		222,120		222,120	677,485
Material and Aquisition Contracts							
2 Workstation computers	17,520	35,040					35,040
Total Material and Aquisition Contracts		35,040					
Miscellaneous and Other Direct Costs							
Expendable supplies		500		500		500	1,500
#/yr $/trip							
Travel 8 200		1,600		1,600		1,600	4,800
Miscellaneous and Other Direct Costs		2,100		2,100		2,100	6,300
Overhead Misc and Other Direct Costs	0.445	935	0.445	935	0.46	966	12,600
Total Miscellaneous and Other Direct Costs		5,135		5,135		5,166	23,700
Total Cost		395,705		355,653		363,505	1,114,863

Table 2. Budget - University of California, Davis, prime contractor

BUDGET-VESTRA RESOURCES, INC

COST CATEGORY	1997-98 BUDGET RATE	AMOUNT	1998-99 BUDGET RATE	AMOUNT	1999-2000 BUDGET RATE	AMOUNT	TOTAL BUDGET
Direct Salaries and Benefits							
2 Staff Researchers							
1 GIS Analyst							
1 Programmer							
Direct Labor Hours	2,464		2,464		2,464		
Total Direct Salaries and Benefits		86,240		86,240		86,240	258,720
Overhead Labor	1	86,240	1	86,240	1	86,240	258,720
Miscellaneous and Other Direct Costs							
Miscellaneous Computer		24,640		24,640		24,640	73,920
Other (meetings, reports travel)		25,000		25,000		25,000	75,000
Miscellaneous and Other Direct Costs		49,640		49,640		49,640	148,920
Total Cost		222,120		222,120		222,120	666,360

Table 3. Budget - VESTRA Resources, Inc., subcontractor

UNIVERSITY OF CALIFORNIA, DAVIS

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HYDROLOGY
VEIHMEYER HALL
(916) 752-0453
FAX: (916) 752-5262

DAVIS, CALIFORNIA 95616-8628

July 22, 1997

Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

Dear Ms. Hansel:

University of California requests a sole source subcontract with Vestra Resources, Inc. We have a unique hydrology model (SPLASH) and Vestra Resources has a unique resource planning model Ep(x) and a unique fire generator model (FIREGEN). We will link these models together for the first simulator of ecosystem processes related to fire, water and land management. Without these models such a monitoring system would not be possible. We hope to have an opportunity to share with you the special capabilities of these efforts.

Sincerely,

Wesley W. Wallender

Wesley W. Wallender
Professor, Departments of Land Air and Water Resources (Hydrology Program) and
Biological and Agricultural Engineering

c. Russ Fletcher, Vestra Resources, Inc.

V. APPLICANT QUALIFICATIONS

The proposal is being submitted by the Office of the Vice Chancellor for Research of the University of California at Davis. The technical leadership of the university will be provided by two members of the faculty in the Department of Land, Air, and Water Resources, **Drs. Wesley W. Wallender and Susan L. Ustin**, who are recognized for their expertise in vegetation and hydrologic modeling, remote imagery, and terrestrial and aquatic systems interpretation. Dr. Wallender served as director of the University of California Salinity/Drainage Research Program, and he and Dr. Ustin have developed a model that defines the stream flow and velocity over time of hydrologic systems which are precipitation and irrigation driven. Dr. Ustin served as a science team member of the Sierra Nevada Ecosystem Program, and she currently is a member of the NASA EOS Sellers-Mooney Interdisciplinary Science Team on Atmosphere-Biosphere Interactions. She chairs the Graduate Ecology Program in Ecosystem and Landscape Ecology. **Dr. Peter B. Moyle**, Professor in the Department of Wildlife and Fisheries Biology, will support their work by evaluating the aquatic habitat implications of alternative management decisions and natural stressors, and the impacts on aquatic species of concern. Dr. Moyle is a fellow of the California Academy of Sciences and also served on the Sierra Nevada Ecosystem Program team

Dr. L. Russell Fletcher and Scott P. Holmen will be the technical leads for work to be carried out by Vestra Resources staff. Dr. Fletcher has been providing the operations research and ecosystem modeling and simulation support for many land and water use projects, and developed the stochastic fire disturbance model to be used in this project. **Mr. Holmen** has been involved in the development of user-friendly software and computer simulation for nearly two decades. Among the modeling tools for which he is responsible is an ARC/INFO GRID-based model which determines whether certain lands within a study area are suitable for different types of activities. The Ep(x) land use and planning model to be used in this project was developed by VESTRA Resources, Inc.

Jane H. Turnbull will coordinate the activities of the project, including the meetings of the oversight panel. Until a year ago, Ms. Turnbull was Manager of Integrated Biomass Systems at the Electric Power Research Institute and was responsible for defining strategies appropriate for the development and use of environmentally sound and economically viable biomass resources. **Dr. Lawrence S. Davis,** former S.J. Hall Chair in Forest Economics at the University of California at Berkeley, will facilitate the meetings of the oversight panel.

The Eldorado National Forest will support this work by allocating staff participation and by providing access to the data and formats used in the forest's GIS. **Susan Rodman**, assistant forest planner and GIS supervisor, will serve as consultant on forest planning. She will be aided by **Peggy O'Connell,** forest ecologist, and **George Elliott,** forest fisheries biologist.

Persons who have committed to serve on the oversight panel for this project include the following: **Dr. Reginald H. Barrett**, Professor of Wildlife Biology and Associate Director, Center for Assessment and monitoring of Forest and Environmental Resources at the University of California at Berkeley. Dr. Barrett was granted the title of Certified Senior Ecologist by the Ecological Society of America in 1993. He has been a leader in the development of the Wildlife Habitat Relationships program in California. **Dr. Bruce R. Hartsough**, is Professor of Forest Engineering at the University of California at Davis. His expertise includes the modeling and systems analysis of forest operations, and the environmental impacts of harvesting operations. **Carl N. Skinner,** is fire ecologist and biogeographer for the USFS Pacific Southwest

Experiment Station. He served as a special consultant on fire to the Sierra Nevada Ecosystem Program and as liaison to NASA Ames in interpretation of multi-spectral imaging of wildfire events. **Dr. Richard Standiford** is the Director of the Integrated Hardwood/Range Management Program at the University of California at Berkeley, and has considerable knowledge of the oak woodland foothills areas that will be modeled in this project. . **Dr. Sari Sommarstrom** is a consultant in natural resource planning and water resource analysis. She is currently working on the Coastal Salmon Initiative for the California Resources Agency where her emphasis is on outreach to private landowners. She presently is also president of the national Watershed Management Council. **Michael R. Eaton** is director of the Cosumnes River Project for The Nature Conservancy. As director, he is responsible for communications, strategy, and fund-raising, as well as planning, property acquisition, and management activities. **Peggy O'Connell,** will serve as the point person on the panel for the Eldorado National Forest. **Dean Swickard** will serve as representative of the Bureau of Land Management's Folsom Resource Area. Dean is the area manager for the 220,000 acres of BLM lands in 21 counties of central and eastern California. **Gregory Greenwood or William Stewart** will represent the California Department of Forestry and Fire Protection. **Ray Nutting,** El Dorado County supervisor, will represent the interests of that county, and **Mark Hicks,** director of the El Dorado County Resource Conservation District, will represent local farming and grazing interests. Both Messieurs Nutting and Hicks have leadership roles in the establishment of the Cosumnes Partnership. **Douglas Leisz**, former deputy regional director for USFS Region IV, has also been working on the Cosumnes Partnership. **Don Tomascheski**, vice-president with **Sierra Pacific Industries** has agreed to allow us to use their data sets as well as provide access to their lands.

The parties involved in the development of this proposal do not believe that any conflicts of interests exist. The project participants are committed to the success of this endeavor, recognizing that its success will contribute to the overall welfare of everyone living in the western United States, most particularly those persons dependent on the ecological health of the northern California watersheds and the quality and reliability of the water flowing into the Delta and San Francisco Bay.

The following is an abbreviated and partial list of related jobs successfully completed by the subcontractor, VESTRA Resources, Inc.:

GIS Pilot Studies - *California Department of Forestry and Fire Protection*

Acting as the prime contractor, VESTRA worked with ESRI on two pilot GIS projects for the California Department of Forestry and Fire Protection (CDF). The focus of the first pilot study was fire protection at the urban/wildland interface. The focus of the second study was forest management, watershed management, and cumulative effects. The projects involved determining user needs at the ranger-unit level, developing a database design to meet those needs, and developing recommendations on hardware-software configurations appropriate to the needs of CDF's field forces.

GIS Services - *USFS Region 5*

VESTRA has held two consecutive indefinite quantities contracts to provide GIS Services to US Forest Service Region 5 during the past 6 years. Under these contracts, VESTRA has completed numerous GIS projects in the Northern California area of Region 5 at both the national forest and district levels.

Lewis River GIS - ***PacifiCorp***

VESTRA worked with PacifiCorp's environmental services, property management, and recreation departments to evaluate user needs and to develop a detailed database design for the Merwin Hydroelectric Project...This analysis will be integrated into Washington state Department of Natural Resource's Integrated Land Management Plan.

North Umpqua Relicensing GIS - ***PacifiCorp***

VESTRA worked with PacifiCorp to assess GIS information and analysis needs for its North Umpqua Hydroelectric Project, an area in central Oregon containing 42 miles of canals and 8 power-generating facilities. VESTRA then designed and implemented a GIS to support environmental and engineering studies required by the Federal Energy Regulatory Commission along transmission lines to protect sensitive resources... VESTRA continues to work with PacifiCorp on its watershed analysis of this 700,000-acre project.

Strategic Forest Plan for Jackson Demonstration State Forest - ***California Department of Forestry and Fire Protection***

VESTRA is part of an interdisciplinary team (the only team that met state-specified qualifications), selected to prepare a multi-species habitat conservation plan(HCP) and sustained yield plan (SYP) for the 50,000-acre Jackson Demonstration State Forest (JDSF) in Mendocino County, California.

Forest Vegetation Classification and Accuracy Assessment - ***NASA-EOCAP***

Under contract with NASA, Dr. Greg Biging at the University of California and a team of other in-kind contributors and participants, including VESTRA, performed an in-depth assessment of photointerpretation methods and developed new, innovative techniques using LANDSAT Thematic Mapper (TM) data for the purpose of improving the accuracy of determining species, size, class, and density of forested polygons.

Forest Planning and GIS - ***The Pacific Lumber Company***

VESTRA has been working with The Pacific Lumber Company for several years developing GIS-based alternative forest plans. These forest plans incorporate a 120-year planning horizon and have allowed PALCO managers to evaluate and explore many alternatives, increasing their understanding of the issues affecting the management of their lands, the options available to them, and the environmental and economic consequences of these alternatives. PALCO is applying these analyses to support development of its sustained yield plan (SYP) and multi-species habitat conservation plan (HCP) using VESTRA's Ep(x) analysis toolset.

Louisiana-Pacific Corporation

VESTRA worked with Louisiana-Pacific Corporation's (L-P) Forest Resources and Fiber Procurement Division for nearly 4 years to develop a comprehensive GIS database for its 450,000 acres in California Currently, VESTRA is completing a 2-year, groundbreaking project that provided L-P with a methodology, software, and GIS and associated databases to support the planning and implementation of an ecosystem-management-based sustainable forestry program for their lands.

VI. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

All terms and conditions are agreeable to and will be complied with by the applicant.

I-000730

Item 8

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California

OFFICIAL'S NAME Sandra M. Dowdy Contracts and Grants Analyst	
DATE EXECUTED JUL 25 1997	EXECUTED IN THE COUNTY OF YOLO
PROSPECTIVE CONTRACTOR'S SIGNATURE Sandra M. Dowdy	
PROSPECTIVE CONTRACTOR'S TITLE	
PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME THE REGENTS OF THE UNIVERSITY OF CALIFORNIA	